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FROM THE AGRICULTURAL JOURNAL OF INDIA, VOL. II, PART II, APRIL, 1907

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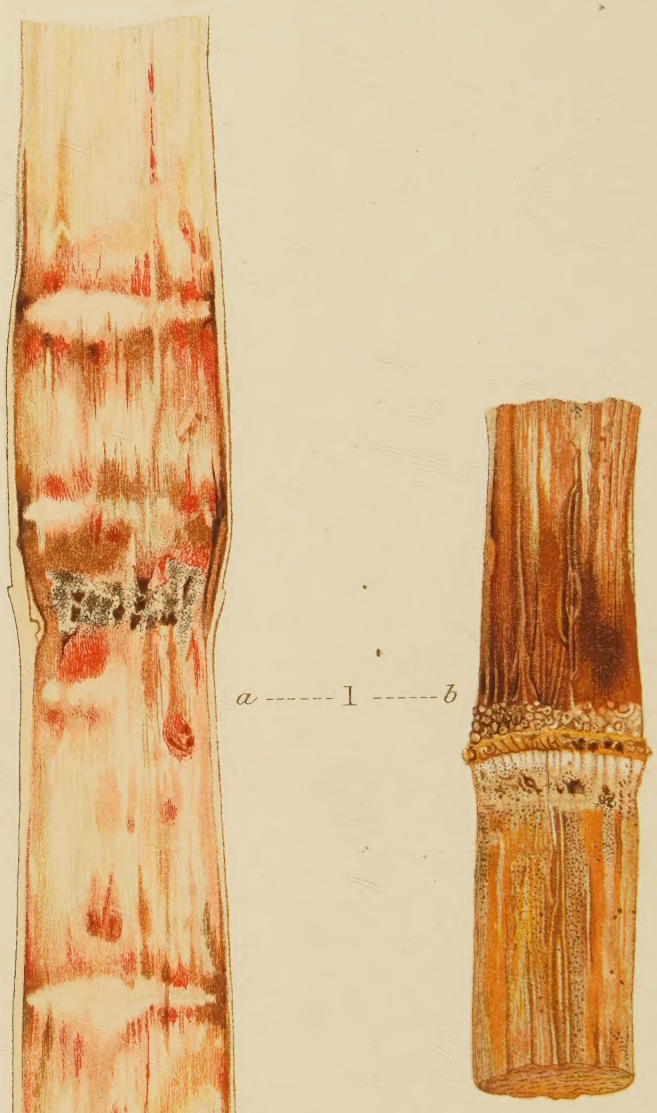
PLATE XI.



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[*Reprinted from the Agricultural Journal of India*, Vol. II, Part II.]

THE SELECTION OF SUGARCANE CUTTINGS.

By E. J. BUTLER, M.B., F.L.S.,

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The losses caused by diseases of the sugarcane are yearly attracting more and more attention in every cane-growing country, and it is gradually becoming recognized that the question of their prevention is one of the chief problems that sugarcane planters have to face. This is not less the case in India than elsewhere, for a number of sugarcane diseases are already known in this country, and one of them—red rot or red smut—is the cause of very great damage to the crop in many places.

Red rot is caused by a minute fungus, *Colletotrichum falcatum* Went, which grows in the cane pith, producing a red discolouration of the latter. Plate XI, Fig. *a.*, shows an infected cane split longitudinally. The red markings are peculiar in some respects, and are sufficient to enable any one with a little practice to recognize the disease. The first point that will be observed is that the discolouration does not affect the whole of the pith uniformly. It has a tendency to appear in sharply marked streaks or lines, these indicating, for the most part, the fibres which run along the pith and contain the water vessels of the plant. The colouration is usually greatest at the nodes or joints, and less, but still visible in streaks, between the joints. Here and there white patches surrounded with a red ring are visible, and it is noticeable that these patches extend across the cane, not along it. None of the other injuries to cane, which cause reddening of the pith, produce these white patches, and their presence in any cane is an infallible sign that it is attacked by red rot.

The diseased cane figured in Plate XI, Fig. *a.*, is an early case, while the pith is still juicy. Later on it dries up and turns dark

grey or mud coloured. In the first stage there is not usually much indication of the disease on the outside of the cane, which is still full and rigid. When drying up occurs, however, the cane collapses between the joints and shows long wrinkles where it has fallen in ; at the same time it becomes soft or brittle and can easily be bent or broken off. Early in this second stage a number of little black dots appear on the surface (Plate XI, Fig. *b.*), and the fungus comes to light. These dots, which are the spore beds, collect chiefly at the joints, but also appear in the wrinkled parts between. They are often rare or hard to find, and are so small that the use of a lens is necessary to see them clearly.

The spores that are formed in these black spore beds can germinate if sown on nutrient jelly or even in moist earth, and produce a mould-like growth of the fungus on the surface. A little of this inserted into the pith of a healthy cane can set up red rot and quickly lead to the discolouration of a small patch of the neighbouring pith. Hence the fungus is a parasite which can live in the soil or on decaying leaves in the fields, when it has no sugarcane to feed on. Just how long it can survive away from the cane is not known, but there is evidence to show that, ordinarily, three or four months is enough to cause its disappearance from the soil.

It is, of course, evident that the spores, instead of falling on the soil, may lodge on healthy canes near by and infect them directly. This would be extremely common, no doubt, but for the fact that the cane rind offers a barrier which the fungus is unable to pass. Hence to reach the pith and set up red rot, it must fall on some broken or damaged part of the rind. Unfortunately, as every one knows, the cane rind is frequently damaged, either by the holes of borer insects, or by cracks that form naturally in many varieties while the cane is ripening. If the spores fall into these wounds, a small patch of red rot is set up, sometimes of sufficient severity to kill the particular cane affected.

In some parts of India, as in the Godaveri Delta, this death of single canes in a stool, from the entry of the parasite through a wound, is common. Most cane fields show a number of such

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PLATE XII.

cases. In other parts of India as in Behar, it is not so common. This is possibly due to the drier climate of these parts after October when the spore production of the fungus begins. It is extremely rare in Behar to find any spores before November, and it is possible that, at this time, the natural conditions are such that, even should spores be blown on to a wounded cane, they cannot germinate or grow with sufficient vigour to cause the death of the cane. If so, then the past year must have been abnormal in some respects, for a large number of wound infections occurred at Pusa, though as previously said they are not usually common in this part of the country.

Now, there is another aspect of the matter to be considered. Sugarcane is usually grown from sets or cuttings, not from seed. It is evident that amongst these cuttings some will have the rind broken by wounds. Some of these damaged sets will have been infected by red rot as just described, and the set will be planted out *with the parasite in it.* Further, if infection of the wounded cane has occurred sufficiently early in the season, the fungus may have extended two or three feet along the cane (producing always the red discolouration of the pith), and not one, but three or four, diseased sets may be planted from a single infected cane. Of course, if the infection were very severe, the cane would be dead at planting time and would not be used for seed; but a large number of the canes at planting time will be just sufficiently infected to show the discolouration, but will still look healthy externally and be quite juicy, so that, unless the reddening is accepted as a danger signal, they will be planted.

What this may result in is shown in Plate XII. Alternate rows of reddened and unreddened sets of a Madras cane, known as *yerra*, were sown at Pusa in 1906. The unreddened sets germinated well and gave a promising-looking crop. The reddened ones on the other hand germinated badly, and even of those that did come up, a number died in the following two or three months. On digging these up and examining them, it was found that the parasite had grown into the new shoots and killed them. It is probable that many of the sets which fail

to germinate, and which are usually said to be killed by white-ants, are really killed by red rot, and the white-ants are merely followers that feed on the dead cane.

Very often it happens that the red rot fungus, though present in the planted set, fails to kill the young shoots on germination. Why this should be it is difficult to say, as it is one of those mysteries connected with the struggle between host and parasite, about which we are still very much in the dark. Sometimes the parasite gets the upper hand and kills the young plant; sometimes the young plant is too strong for the parasite and keeps it in check. However, even in this latter case, the parasite is not got rid of, but merely remains dormant in the stool. As the cane begins to contain an appreciable quantity of sugar, the fungus resumes its growth, and will be found flourishing very vigorously about September or October in Behar. Hence, about this time, numbers of cane clumps begin to show signs of disease. The fungus is now attacking the most vital part of the cane, the base of the stool, and spreading from here up into each individual cane. One after another each cane in the stool withers, the oldest first, until the whole clump is destroyed. This is the form of the disease with which every planter in Behar is familiar, and the point which I wish to emphasise is that spore infection in the particular year has nothing whatever to do with it, for when it begins, there are scarcely any spores about; it is the result of planting sets containing the parasite already within them.

It may be asked, in regard to this, whether spores from the soil may not attack the growing crop. Apart from the fact that the spores do not live long in the soil, this has been shown by another experiment not to occur commonly. Pieces of land that had borne a diseased crop the previous year, and consequently were plentifully charged with spores, were replanted with healthy seed. Even when the variety used was one that is subject to the disease and was, therefore, not a naturally immune kind, no appreciable disease resulted.

The effect of rattooning diseased cane may be anticipated from what has been said. Where disease has been severe, a large

PLATE XIII.

number of the stools left in the ground after cutting the crop, will contain the fungus. This has been proved by actual observation. When the second crop grows from these stools, the fungus may, as already said, remain dormant for some months. But, as the cane matures, the parasite resumes activity, and gradually clump after clump withers. Plate XIII shows an extreme case of this. The diseased variety *yerra* was rattooned at Pusa along with the other varieties in 1906. The previous crop had been very badly diseased. In spite of this the rattoons grew fairly well at first. During the monsoon they began to wither, and by December the condition shown in Plate XIII was seen. The variety occupied a long narrow plot in the middle of the other rattooned varieties. The whole of it died out, while the neighbouring varieties remained quite healthy, so that the appearance was as if a road had been cleared right through the cane field.

Now, all this makes it clear that the examination of the cuttings for red rot at the time of planting is a very important matter. Almost every cane field contains some plants attacked by red rot. It is not possible absolutely to prevent its appearance. The spores cannot all be destroyed, do what we may. Disease in plants, as in man, can never be entirely exterminated, but it can be checked and prevented from becoming epidemic. That is all we require to aim at—to keep it down within reasonable limits. Of all the precautions which can be taken to check cane diseases, the most important is the selection and examination of the seed. It should be as essential a part of the routine practice in planting as the preparation of the soil.

To this it may be objected that in some places, and with some cane varieties, there is no disease, and seed examination for red rot is just so much waste of time. This is a very dangerous argument. It is extremely difficult to say, without examining the sets, whether disease is present or not. No variety of cane, so far as is known, can be said entirely to withstand it. It is true there is a great difference in the liability of different varieties to infection. Certain races of cane seem to become so impregnated with disease that it is hard to get any of them free from it, while

others have so little that a careful search is necessary to find cases. But, even in the latter kinds, unless all diseased sets are weeded out at planting time, the number increases year by year and may become considerable. Sometimes, too, it happens that a bad season so weakens the constitution of a variety, or so increases the number of spores, that cases of infection through wounds become numerous, and the succeeding crop will have to be very carefully handled to avoid an epidemic. The examination of sets is an insurance against disease, and even if wasted for several years, is a precaution that cannot be neglected without probability of disaster.

The attacks of red rot are very insidious. An instance of this may be given from my own experience. A race of cane known to be very generally infected was grown on a large estate. In spite of its general failure elsewhere, it gave for some years good crops and no danger was anticipated. In 1905 the fungus must have accumulated considerably and conditions then became favourable for its action. As a result, the very large acreage under this variety gave scarcely twenty per cent. of a full yield. The loss was thousands of pounds and might have been avoided if the presence of the disease had been detected by inspection of the sets. Mr. Barber has described, in the account of the Samalkota Sugarcane Farm, contributed to the first number of this journal (Vol. I, page 45), how successive canes have held favour in the Godaveri Delta during the past forty years, each in turn growing luxuriantly and bringing wealth, but after a few years becoming diseased and causing widespread loss. As a result of bad cultivation and neglect of seed selection, each cane variety in turn became thoroughly infected and had to be abandoned.

In selecting seed for cane-planting the first point to be considered is the selection of the variety. In this the past history of the cane must be taken into consideration. I have already given an instance to show how dangerous it is to grow a variety from stock known to have been seriously infected, even though the crop may be promising for the first few years. Only seed from a variety which is known to be practically free from

disease, and to have been so for some years, should be selected. On large estates it is unquestionably best to be self-contained in the matter of seed supply. When starting a new plantation or in small estates, this is often not possible, and seed must be obtained from outside. If this is necessary on a large scale, care should be taken to select a locality as similar as possible, as regards soil and climatic conditions, to that where the cane is to be grown. Sugarcane appears to be particularly susceptible to change of conditions, and the introduction of large quantities of seed from a locality with a different climate and soil is liable to lead to deterioration, at any rate temporarily. This does not affect nursery cultivation. There is no possible objection to the introduction of new varieties on a small scale, in fact it is highly advisable to do so wherever feasible, and the maintenance of a nursery for the experimental cultivation of promising varieties is strongly to be recommended. The best of attention should be given to the nursery crop, and as soon as a variety has been tested and found satisfactory, it can be increased on a field scale, a succession of healthy seed being thus brought forward into cultivation. In introducing new varieties from abroad, it should be remembered that several of the cane diseases of other countries do not occur in India, and nursery cultivation on a small scale is absolutely imperative in this case, so as to allow of the prompt destruction of any variety which shows signs of disease.

In harvesting the seed cane much trouble in the later part of the operations can be saved by leaving out all diseased plants or patches. Some disease is almost sure to be found at harvest time, so undesirable looking canes should be left behind. This will, undoubtedly, save time and expense later on. Rejected plants may be crushed if they are worth it or, if not, they should be collected and burnt. They should on no account be left standing or ploughed in, as old dried-up canes often contain large quantities of the fungus which is capable of remaining alive in them for many months.

Where disease is prevalent, it is probably better to plant tops than cuttings from the whole cane. From the ordinary

plantation point of view, indeed, the opinion is held in many cane-growing countries that tops give the best crops. With this I am not so much concerned here as with the question of the relative freedom from disease of tops as compared with whole cane cuttings. It is well known that the top part of the cane is poorest in sugar, and it is also better protected by the leaf sheaths, which completely cover the upper joints. It is, therefore, at least probable that these upper joints are less commonly attacked with red rot, and, though no comparative experiments have yet been carried out to determine this point, the probabilities are that, from the disease point of view, the tops furnish the best seed.

The general practice in India is, however, to plant cuttings obtained from the whole cane. These are cut into lengths containing, usually, three joints. The preparation of these should be entrusted to experienced men, as it is important for several reasons that the ends should be clean cut and not shattered. In inspecting the cuttings, the ends are the points chiefly requiring examination, and this is much easier with a clean cut surface than with a jagged one. Besides, it is very important that the part left between the end joint and the cut should be undamaged as far as possible. This is the weak point of the cutting, and the road through which not alone several parasitic fungi, but also white-ants, attack the cane. If not clean cut, rotting sets in and, if the shattering at the end be considerable, will reach the bud, before it has become independent of the set, and cause its death. Hence it is very important that the cutters should be experienced at their work.

The cut sets at Pusa are collected by boys into bundles of ten or fifteen sets, which are then inspected at the cut ends before being placed in baskets to carry on to the field. In the inspection the main point to be examined is the presence of any suspicious discolouration of the pith. Any sign of reddening of the fibres should be taken as an indication of the possible existence of red rot. In most cases cultures made from the pith of sets showing reddened fibres at the ends give a growth of the red rot fungus. Sometimes other parasitic fungi are concerned, and also

insects. But in any case it is necessary to reject all cuttings with reddening at the ends. Borer holes should also be looked for, as bored sets sometimes contain the fungus in the immediate neighbourhood of the hole, while apparently healthy at the ends.

The inspection of the sets can be carried out by any reliable overseer with very little practice. There has never been any difficulty at Pusa in training men to do it well. Even the cutters themselves, after a time, become fairly careful in rejecting any cutting which shows signs of injury. The result has been that at Pusa we have not had any general disease, except in the case of the variety *yerra* previously mentioned, and the death of whole clumps has been very rare in the varieties grown, some twenty-five in number. This has been the case although the last two seasons have been, undoubtedly, very favourable for the attacks of the parasite, owing to the monsoon floods. This year there was a large number of single cane infections above the ground, but at harvest time it was found that these did not affect whole clumps and were clearly cases of new infections, probably through wounds, and there is no reason to anticipate any difficulty in keeping the new crop healthy. We have succeeded up to date in preventing the epidemic form of the disease, which results in the loss of whole clumps, while being unable to check the cases of new infection of individual canes. The disease appears to be under such control that in good seasons we may expect little or none and even in bad seasons, such as last year, we should not have any general destruction of the crop.

DESCRIPTION OF THE PLATES.

Plate. XI.—Appearance of sugarcane attacked by red rot. Fig. *a*.—A cane split open to show the reddening of the pith. Fig. *b*.—External view of a cane, showing the black spore beds of the fungus at the joint, and also in longitudinal hollow below the joint.

Plate. XII.—Photograph of a plot planted with reddened and unreddened sets of *yerra* cane in alternate rows. Three months after planting.

Plate. XIII.—Photograph of a rattooned plot of diseased *yerra* cane, nine months after rattooning. The whole of the variety has been destroyed by red rot.